

**REMARKS**

Claims 3-10 are pending the application with claim 3 being the only independent claim. Claims 1 and 2 are cancelled without prejudice to or disclaimer of the subject matter therein. Claim 10 is new. Claims 3-9 are amended.

**TITLE OF THE INVENTION**

Applicant has amended the title as required by the Examiner.

**REJECTIONS UNDER 35 U.S.C. § 102**

**Japan Patent App. No. 9-246242 and Japan Patent App. No. 9-246264**

Claims 1, 2 and 5 are rejected under 35 U.S.C. § 102(b) as being anticipated by each of Japan Patent App. No. 9-246242 (the '242 reference) and Japan Patent App. 9-246264 (the '264 reference). Applicant has cancelled independent claims 1 and 2.

Claim 5 depends from and adds additional features to independent claim 3. As such, claim 5 is not anticipated by the '242 reference or the '264 reference for at least the reasons that claim 3 is not anticipated by the '242 reference and the '264 reference. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection of claim 5.

**U.S. Patent No. 6,091,081 to Matsubara *et al.***

Claims 1-9 are rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,091,081 to Matsubara *et al.* (the '081 patent). Applicant has cancelled claims 1 and 2. The present invention relates to a semiconductor device. The semiconductor device includes a substrate; an insulating film of a fluorine-contained

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carbon film formed on said substrate, wherein the surface of said insulating film is irradiated with hydrogen plasma; a wiring layer of copper formed on said insulating film; and an adhesion layer formed between said insulating film and said wiring layer, for preventing said wiring layer from being peeled off from said insulating film. The adhesion layer includes a metal layer of a metal, and a layer of a compound containing carbon and said metal.

The '081 patent relates to a semiconductor device having an insulating film 4 comprised of a silicon excess layer 41, a diamond-like-carbon (DLC) film 42, a carbon fluoride film 43, another DLC film 44 and another silicon excess layer 45. See the '081 patent, column 8, lines 9-20; column 15, lines 33-38. The silicon excess layer may be comprised of a silicon oxide film, a silicon nitride film, or a silicon oxi-nitride film. See the '081 patent, column 5, lines 6-9.

However, the '081 patent does not disclose an adhesion layer between an insulating film and a wiring layer that includes a "metal layer of a metal" and "a layer of a compound containing carbon and said metal," as recited in independent claim 3. The '081 patent only discloses a layered insulating film using non-metals. As such, claim 3 is not anticipated by the '081 patent. Accordingly, Applicant respectfully requests that the Examiner reconsider and withdraw this rejection.

Claims 4-9 depend from and add additional features to independent claim 3. As such, claims 4-9 are not anticipated for at least the reasons set forth above. Accordingly, Applicant respectfully requests that the Examiner withdraw this rejection of claims 4-9.

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**U.S. Patent No. 5,866,920 to Matsumoto et al.**

Claims 1-9 are rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 5,866,920 to Matsumoto *et al.* (the '920 patent). As stated above, Applicant has cancelled claims 1 and 2.

The '920 patent discloses a semiconductor device having multiplayer interconnection structure comprising an insulating film 231 having silicon oxide films 2311 and 2313 on opposing sides of a carbon fluoride film 2312. See the '920 patent, column 13, lines 12-20; FIG. 8(a)-(c). Insulating film 231 is disposed on a silicon wafer 21. See *id.* A silicon nitride film 25 is disposed on insulating film 231. See FIG. 8(b). In place of silicon nitride film 25, either a silicon nitride film or an oxynitride film may be used. See the '920 patent column 14, lines 26-28. Tungsten is disposed to fill a contact hole. See the '920 patent, column 14, lines 17-21.

However, the '920 patent does not disclose an adhesion layer between an insulating film and a wiring layer, that includes a "metal layer of a metal" and "a layer of a compound containing carbon and said metal," as recited in claim 3. The '920 patent only discloses a silicon nitride film disposed on an insulating film and a tungsten layer disposed adjacent to the silicon nitride film. As such, claim 3 is not anticipated by the '920 patent. Accordingly, Applicant respectfully requests that the Examiner reconsider and withdraw this rejection.

Claims 4-9 depend from and add additional features to independent claim 3. As such, claims 4-9 are not anticipated for at least the reasons set forth above. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection of claims 4-9.

## REJECTIONS UNDER 35 U.S.C. § 103

### **The '242 Reference**

The Examiner rejected claims 3, 4 and 6-9 under 35 U.S.C. § 103 as being unpatentable over the '242 reference. The Examiner stated that there is no specific disclosure of the critical nature of the dimensions or any unexpected results. Applicant has amended claim 3 to include the subject matter of canceled claim 2 and the additional feature of an insulating film irradiated with hydrogen plasma.

Claim 3 would not have been obvious in view of the '242 reference because the '242 reference fails to teach or suggest an insulating film that is irradiated with hydrogen plasma. The hydrogen plasma irradiated film has a decreased fluorine and high carbon concentration, thereby reducing the chance of peeling of other layers. See Specification, page 7, lines 13-18; page 11, line 27-page 12, line 16. Because the '264 reference does not teach or suggest all the features of claim 3, claim 3 is allowable over the '242 reference. Applicant respectfully requests that the Examiner allow claim 3.

Claims 4 and 6-9 depend from and add additional features to independent claim 3. As such, these claims are allowable for at least the reasons set forth above. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection of claim 4, and pass it to allowance.

### **The '264 Reference in view of U.S. Patent No. 4,985,750 to Hoshino**

The Examiner rejected claims 3, 4 and 6-9 under 35 U.S.C. § 103 as being unpatentable over the '264 reference in view of U.S. Patent No. 4,985,750 to Hoshino (the '750 patent). Applicant has amended claim 3 to include the subject matter of canceled claim 2 and the additional feature of an insulating film irradiated with hydrogen

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plasma. The combination of the '264 reference and the '750 patent fail to teach or suggest the invention as claimed.

The Examiner relies upon the '750 patent to show an adhesion layer. The '750 patent discloses a metallic layer 20 deposited on an insulating film 18 and in the contact hole 18a, using Ti, Al or Pt. See the '750 patent, column 3, lines 28-32. A barrier metallic layer 22 is deposited on the metallic layer 20, using TiN, W, Wn ZrN, TiC, Wc, among others. See the '750 patent, column 3, lines 48-64. The Cu metallization film 24 is deposited on the barrier layer 22. See the '750 patent, column 4, lines 3-4.

The claimed invention would not have been obvious in view of the '264 patent and the '750 patent because neither reference teaches or suggests an insulating film that is irradiated with hydrogen plasma. The hydrogen plasma irradiated film has a decreased fluorine and high carbon concentration, thereby reducing the chance of peeling of other layers. See Specification, page 7, lines 13-18; page 11, line 27-page 12, line 16.

The combination of the '264 reference and the '750 patent only teaches applying a barrier layer on a metallic layer and a copper metallization film on the barrier layer. Neither the '264 patent nor the '750 patent, alone or in combination, teach or suggest all the features of claim 3. Accordingly, amended claim 3 is patentable over these references. Applicant respectfully requests that the Examiner allow claim 3.

Claim 4 depends from and adds additional features to independent claim 3. As such, claim 4 is patentable for at least the reasons set forth above. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection of claim 4, and pass it to allowance.

**The '264 Reference**

The Examiner rejected claims 6-9 under 35 U.S.C. § 103 as being unpatentable over the '264 reference. For the reasons set forth above, the '264 reference does not render claim 3 unpatentable. Claims 6-9 depend from and add additional features to independent claim 3. As such, claims 6-9 are patentable for at least the reasons set forth above. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection of claims 6-9, and pass these claims to allowance.

**CONCLUSION**

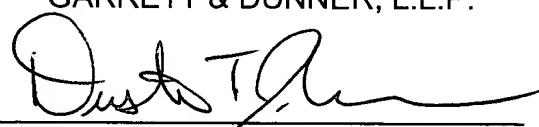
In view of the foregoing amendments and remarks, all outstanding objections and rejections are either overcome or rendered moot. Accordingly, Applicant respectfully requests that the Examiner reconsider and withdraw all the outstanding objections and rejections and allow the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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APPENDIX  
VERSION WITH MARKINGS TO SHOW CHANGES MADE

**AMENDMENTS TO THE TITLE**

The title is amended to read --A Semiconductor Device Having an Adhesion Layer--.

**AMENDMENTS TO THE CLAIMS**

Claims 1 and 2 are cancelled.

Claim 10 is new.

Claims 3-9 are amended as follows:

3. (Amended) A semiconductor device comprising:  
a substrate;  
an insulating film of a fluorine-contained carbon film formed on said substrate,  
wherein the surface of said insulating film is irradiated with hydrogen plasma;  
a wiring layer of copper formed on said insulating film; and  
an adhesion layer formed between said insulating film and said wiring layer, for  
preventing said wiring layer from being peeled off from said insulating film [A  
semiconductor device as set forth in claim 2], wherein said adhesion layer [comprises]  
includes

a metal layer of a metal, and

a layer of a compound containing carbon and said metal.

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4. (Amended) A semiconductor device as set forth in claim 3, wherein said metal layer is formed of an element selected from the group consisting of [a] titanium, molybdenum, chromium, cobalt, tantalum, niobium and zirconium [layer].

5. (Amended) A semiconductor device as set forth in [any one of claims 1 through 4] claim 3 or claim 4, wherein said insulating film is amorphous.

6. (Amended) A semiconductor device as set forth in [any one of claims 1 through 4] claim 3 or claim 4, wherein said insulating film has a film density of 1.5 g/cm<sup>3</sup> or higher.

7. (Amended) A semiconductor device as set forth in [any one of claims 1 through 4] claim 3 or claim 4, wherein said insulating film contains oxygen having a concentration of 3 atomic% or less.

8. (Amended) A semiconductor device as set forth in [any one of claims 1 through 4] claim 3 or claim 4, wherein said insulating film contains nitrogen having a concentration of 3 atomic% or less.

9. (Amended) A semiconductor device as set forth in [any one of claims 1 through 4] claim 3 or claim 4, wherein said insulating film contains boron having a concentration of from 10<sup>-3</sup> atomic% to 1 atomic%.

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